STATUS OF PACIFIC MACKEREL SPAWNING POPULATION, 1974 [1/]

SUMMARY AND RECOMMENDATIONS

This is the second annual report on the status of the spawning population of the Pacific mackerel as required by Section 8388.3 of the Fish and Game Code.

During 1973 and early 1974, several methods of determining population size were used to estimate the spawning population size of Pacific mackerel stocks north of Point Eugenia, Baja California. The estimated Pacific mackerel spawning population obtained by tagging procedures was 2,025 tons. Two alternate spawning biomass estimates also were obtained using partyboat catches fitted to regression lines. The estimates derived by these alternate methods are 4,675 tons, and 8,380 tons.

All 1974 estimates are below the 10,000 ton spawning population minimum set in Section 8388.3 of the Fish and Game Code and thus no harvest under Section 8388.5 of the Fish and Game Code could be allowed.

INTRODUCTION

Pacific mackerel, *Scomber japonicus*, occur from the Gulf of Alaska southward into the Gulf of California. The species was never abundant north of Monterey Bay and in recent years has become scarce north of Point Conception.

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The offshore extent of Pacific mackerel spawning populations, as deduced from larvae catches, is about 150 miles off southern California, 250 miles off northern Baja California, and 200 miles off central Baja California.

Ocean sport anglers take thousands of Pacific mackerel each year. They are usually among the half-dozen species taken in greatest numbers in California's coastal waters. Partyboat landings accounted for 199,104 Pacific mackerel (an estimated 125 tons) in 1973.

POPULATION ESTIMATES

The Department of Fish and Game is required to make an annual estimate of the spawning population of Pacific mackerel to comply with Section 8388.3 of the Fish and Game Code (Addenda 1). During 1973 and early 1974, several methods were used to estimate the spawning population size of Pacific mackerel stocks north of Point Eugenia, Baja California.

Tagging

The principal estimate was made by using tag and recovery data (Addenda 2). This method involves the release and recovery of tagged Pacific mackerel and the utilization of age composition data from the partyboat catch to convert the total population to a spawning population estimate. A total of 1,502 Pacific mackerel was tagged during 1973.

The catch data for Pacific mackerel were obtained from the partyboat fleet operating in California and Mexican waters. Only tagged fish recaptured by the partyboat fleet were used to estimate

the spawning population of Pacific mackerel.

The estimated size of the Pacific mackerel spawning population using tagging data is 2,025 tons.

Alternative Population Estimates

Two other sets of data were used to calculate additional estimates of Pacific mackerel spawning biomass, independent of the tagging method.

The first set of data consisted of partyboat landings of Pacific mackerel captured in waters around Santa Catalina Island correlated with corresponding estimates of spawning population determined for each year previous to 1969. These data were fitted with a trend line (Addenda 3). This statistical trend line is called a linear regression using a least squares fit. The spawning population estimate for 1974, as determined from the regression line, is 8,380 tons.

The second set of data, compiled from central California partyboat catches, was used as an indicator of spawning population size. These data were fitted with a curved line called a power curve (Addenda 4). A spawning population of 4,675 tons was calculated from this set of data.

DISCUSSION

The 1974 spawning biomass estimates for Pacific mackerel are generally smaller than the 1973 estimates. Fish in the spawning biomass which die during the year usually are replaced the next year by a younger incoming year class.

The number of fish in these maturing year classes determines whether the total spawning biomass will increase, decrease or remain

constant. Because of the small size of the 1971 year class (fish just reaching maturity), the total spawning biomass of the Pacific mackerel fell below the 1973 estimated size.

From age class composition data, the 1972 year class (age I) appears to be fairly abundant and thus the 1975 spawning biomass should not drop to a lower level. The 1973 year class has been captured in some incidental catches, but it is still too early to evaluate its strength.

ADDENDA 1

Sections of California Fish and Game Code
Pertaining to Pacific Mackerel

8388. Except as provided in Section 8388.5, Pacific mackerel may not be taken or possessed at any time for any purpose except loads or lots of fish may contain 18 percent or less by weight of Pacific mackerel taken incidentally to other fishing operations. Such Pacific mackerel, incidentally taken, may be used for any purpose. (Amended by Stats. 1972, Ch. 608.)

8388.3. It is the intent of the Legislature that the Pacific mackerel resource be enhanced. During this process a fishery shall be allowed once the Pacific mackerel spawning population, in waters north of Punta Eugenia, Baja California, Mexico, has reached 10,000 tons as determined by the department. Such determination shall be made public in an annual report to the Legislature no later than July 31 of each year. It is also the intent that as the spawning population increases, in excess of 20,000 tons, the seasonal quota also be increased but at such a rate as to allow the continued increase in the Pacific mackerel population. This process should continue with the objective of maximizing the sustained harvest. (Added by Stats. 1972, Ch. 608.)

8388.5. Section 8388 shall remain in effect until the department determines that the estimated Pacific mackerel spawning population, in waters north of Punta Eugenia, Baja California, Mexico, exceeds 10,000 tons. When the department makes this determination, a season harvest quota equal to 20 percent of the amount of Pacific mackerel in excess of 10,000

tons spawning population, as determined by the department, shall be permitted under permits issued by the department.

When the department determines that the spawning population exceeds 20,000 tons, the harvest quota shall be increased to 30 percent of the excess over 20,000 tons.

The department shall keep records of the catch of Pacific mackerel and when it appears that the season quota will be reached, it shall notify all permit holders of the date when such limit will be reached and therefore the season closed, and shall notify, by certified mail, all permit holders of such closure. (Added by Stats. 1972, Ch. 608.)

8388.7. Subject to the provisions of Sections 8388 and 8388.5, Pacific mackerel season is from October 1 through September 30. (Added by Stats. 1972, Ch. 608.)

ADDENDA 2

Estimates of Pacific Mackerel Spawning
Biomass Using Tagging (Mark and Recapture) Methods

The total biomass was calculated using the equation:

$$P = \Sigma n^2(m+u)/\Sigma nm$$

where

P = biomass estimate in numbers of fish.

n = number of marked fish released into the population.

m = number of marked fish recaptured.

u = number of unmarked fish captured.

The values for the equation were calculated to be:

$$\Sigma n^2(m+u) = 1.037108070 \times 10^{11}$$

$$\Sigma nm = 24,990$$

with the biomass estimate in numbers being:

$$P = \Sigma n^2(m+u)/\Sigma nm$$

$$P = 1.037108070 \times 10^{11}/24,990$$

$$P = 4,150,090 \text{ fish}$$

Conversion to pounds is accomplished by multiplying the number of fish times the average weight of fish sampled.

$$P = 4,150,090 \text{ fish} \times 1.2367 \text{ pounds}$$

$$P = 5,132,416 \text{ pounds}$$

The estimated proportion of spawning biomass (determined from age samples) to total biomass is 0.7888; therefore:

$$\text{Spawning biomass} = 5,132,416 \times 0.7888$$

$$= 4,048,450 \text{ pounds}$$

$$= 2,024 \text{ tons}$$

(2,025)

ADDENDA 3

Estimates of Pacific Mackerel Spawning Biomass
Using Partyboat Catch from the Waters off Santa Catalina Island

The spawning biomass was calculated using a least square estimate of $\hat{a}$ and $\hat{b}$ fitted to the line $y = \hat{a}+\hat{b}x$

where

y = biomass estimate in thousands of pounds.

x = number of Pacific mackerel caught off Santa Catalina Island.

$\hat{a}$ = coefficient

$\hat{b}$ = coefficient

The coefficients $\hat{a}$ and $\hat{b}$ were calculated by using the following equations:

$$\hat{b} = \frac{n\Sigma xy - (\Sigma x)(\Sigma y)}{n\Sigma x^2 - (\Sigma x)^2}$$

$$\hat{a} = \frac{\Sigma y - \hat{b}\,\Sigma x}{n}$$

A correlation coefficient was also calculated using the formula:

$$r = \frac{n\Sigma xy - (\Sigma x)(\Sigma y)}{\sqrt{[n\Sigma x^2 - (\Sigma x)^2]\,[n\Sigma y^2 - (\Sigma y)^2]}}$$

The values of the coefficients and the correlation coefficient are calculated to be:

$\hat{a} = -35224.24057$

$\hat{b} = 3.62720696$

$r = .93704902$

with the spawning biomass estimate for 1974 being:

$y = \hat{a} + \hat{b}x$

$y = -35224.24057 + 3.62720696\ (14{,}332)$

$y = 16{,}760{,}900$ pounds

$y = 8{,}380$ tons

ADDENDA 4

Estimates of Pacific Mackerel Spawning
Using Central California Partyboat Catch
as an Indicator of Population Size

The spawning biomass was calculated using a non-linear regression, least squares fit power curve. Data points were fitted to the formula:

$y = aX^b$

where

y = biomass estimate in thousands of pounds

X = number of Pacific mackerel caught off central California from partyboats

a = coefficient

b = coefficient

The coefficients a and b were calculated by using the following equations:

$$b = \frac{n \sum_{1}^{n} (\log_e x_i \log_e y_i) - (\sum_{1}^{n} \log_e x_i)(\sum_{1}^{n} \log_e y_i)}{n \sum_{1}^{n} (\log_e x_i)^2 - (\sum_{1}^{n} \log_e x_i)^2}$$

$$a = \exp\left[\frac{1}{n}\left\{\sum_{1}^{n} \log_e y_i - (\sum_{1}^{n} \log_e x_i) b\right\}\right]$$

A correlation coefficient was also calculated using the formula:

$$r = \frac{n \sum_{1}^{n} (\log_e x_i \log_e y_i) - (\sum_{1}^{n} \log_e x_i)(\sum_{1}^{n} \log_e y_i)}{\sqrt{\left[n \sum_{1}^{n} (\log_e x_i)^2 - (\sum_{1}^{n} \log_e x_i)^2\right]\left[n \sum_{1}^{n} (\log_e y_i)^2 - (\sum_{1}^{n} \log_e y_i)^2\right]}}$$

The values of the coefficients and the correlation coefficient are calculated to be:

$a = 651.9752438$

$b = .618724486$

$r = .77954374$

with the biomass estimate for 1974 being:

$$y = aX^b$$

$$= 651.9752438\ (74)^{.618724486}$$

$$= 9,349,116 \text{ pounds}$$

$$= 4,675 \text{ tons}$$